

A Working Paper Draft

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HISTORICAL PERSPECTIVE: SOME NOTES
ON THE RELATIONSHIP BETWEEN
ENGINEERING, SCIENCE,
AND SOCIETY

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Stages are defined in SEP No. 20(6/9/61)

** For full title of seminar see SEP No. 11-A, page 111

Frederick B. Wood

Residence: 2346 Lansford Ave., San Jose, California, U.S.A.
Mailing Address: P.O. Box 85, Campbell, California, U.S.A.

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Abstract

The engineer and human needs: A discussion of the definitions of the Engineers' Council for Professional Development. The perspective is developed starting with the levels of phenomena described in SEP Nos. 1 and 11-A. The distribution of emphasis is illustrated by a chart.

The graphical historical perspective of the universe, geological eras of the earth, and the cenozoic era is developed which puts the material of SEP No. 9-A in graphic form, suitable for the symbolic use as is done in SEP No. 2, page 1. Then a graphical illustration of the development of modern man and his stages of thinking is prepared to symbolically represent the ideas in SEP No. 10-A.

Frederick B. Wood

Historical Perspective:

Notes on the Relationship between Engineering,
and Society.

a) The Engineer and Human Needs.

The Engineers' Council for Professional Development, which is jointly sponsored by the principal engineering societies including the following on engineering:

The engineer may be regarded, therefore, as an interpreter of science in terms of human needs and a manager of men, money, and materials in satisfying these needs.¹

The mention of "human needs" raises many questions which initially submerge the mathematical and physical aspects under a deluge of social problems involving economic, psychological, political, legal, ethical, and religious arguments. This results in a serious problem of establishing a perspective by which recognition can be given to the social aspects without losing sight of the engineering aspects of communication theory.

The E.C.P.D. has described the research function of engineering as follows:

Research is the process of seeking new knowledge or a better understanding of the significance and relationship of facts already known--the "scientific method" of working from known facts toward the unknown; toward new ideas, facts, principles, materials, or processes. The "pure scientist" is interested mainly in discovering something new; the engineer is interested mainly in turning that something new into something useful.²

¹"Engineering as a career," Engineers' Council for Professional Development, p. 8, 1942.

²Ibid.

Mention of "useful" raises the question of what it is useful for--murder or improvement of the welfare of mankind? This appears to require that the perspective have a large time scale so that the present social problems become very small compared to the total progress of mankind.*

To establish this necessary perspective a distribution of emphasis as shown in Fig. 1 has been employed. The expected distribution for a physics paper is shown compared with the distribution used in an earlier version of this paper. The gap between this paper and the actual investigation of a specific problem is also illustrated. This gap consists of two parts: additional study of the mathematical and physical research previously done in some of the application of communication theory such as the channel capacity of data transmission lines: and a careful survey of the work being done in the social sciences relating to the interpretation of "human needs" and the meaning of "useful." This procedure results in reduction of the coverage of some of the physical aspects of the subject at some stages in order to live up to the responsibilities of an engineer.

The great advances in our scientific knowledge in the last sixty-two years have been accompanied by an increasing degree of specialization. This procedure of concentrating upon a narrow portion of a particular field is necessary for the discovery of new knowledge, but has suffered from defects due

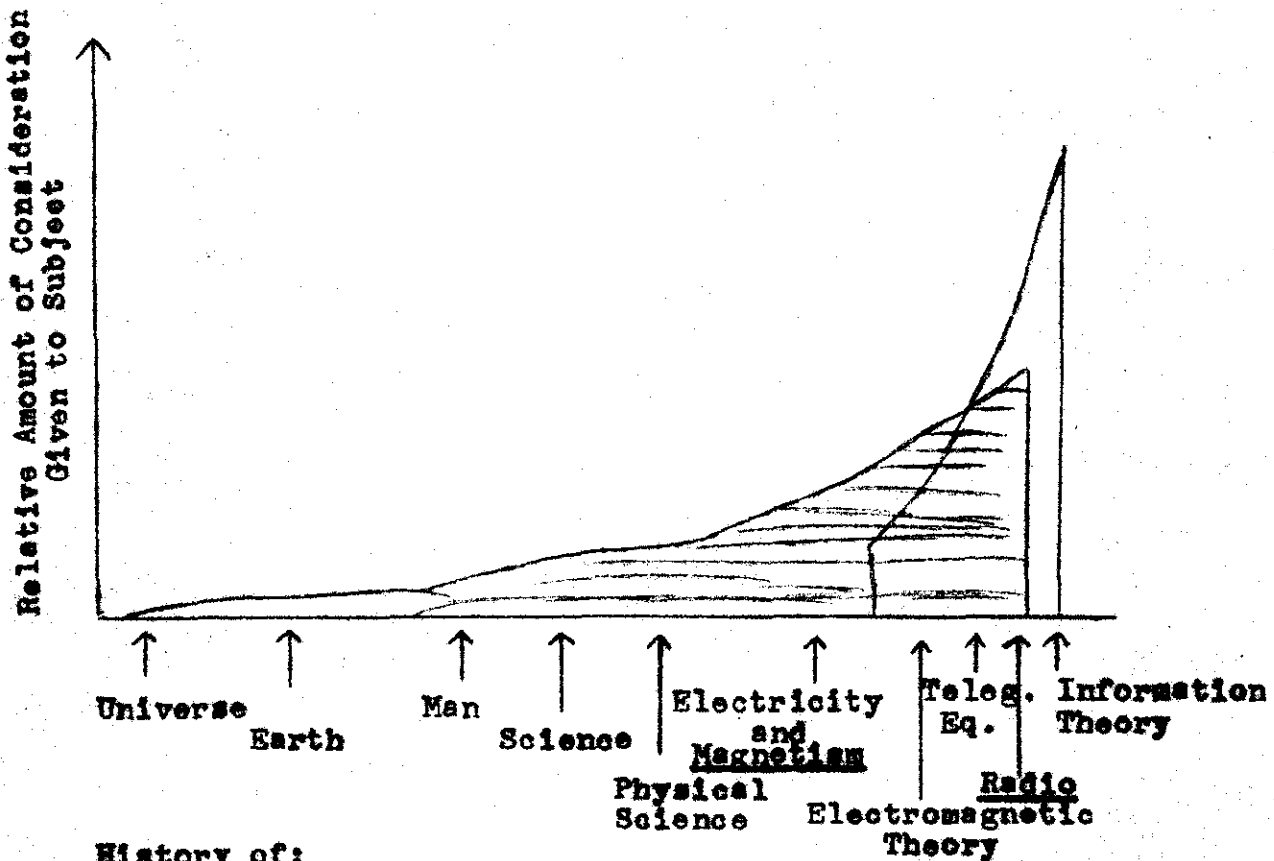
*For other definitions of engineering see supplementary notes.



Distribution of Emphasis Ordinarily Used for a Physical Science Paper.



Distribution of Emphasis Used in this Social-Engineering Paper.



Subject Matter Arranged from More General on Left to More Specific on Right.

Fig. 1 - Approximate Distribution of Emphasis

to the ignorance of some specialists concerning the relationships between their work and the general problems of mankind.

To avoid serious difficulties in the consideration of the history of communication theory, a perspective is here developed to briefly indicate the relationship of progress of knowledge of electromagnetic theory to human progress in general. This perspective can be divided into three parts-- present, historical, and future. The present and historical aspects are briefly mentioned in this memorandum while the future aspects are considered in another report.* Much of this material on perspective is quite elementary. However, it is included here, because there are indications that the neglect of this material may be a contributing factor to the confusion of some engineers and scientists.

The present perspective concerns the understanding of the relationship between different types of natural phenomena. By considering only the more elementary phenomena, we can arrange them in an order of increasing dependency upon the preceding types of phenomena. For brief discussion the following oversimplified arrangement, similar to that of August Comte, can be used in which each type of phenomena is dependent upon the types below it:

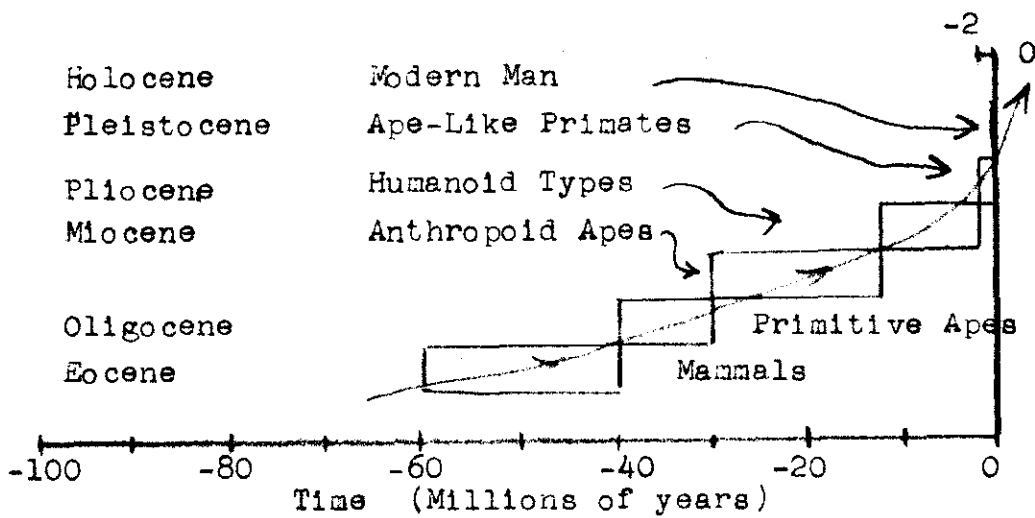
*Socio-Engineering Problems No. 13-A.

Social
Psychological
Biological
Chemical
Physical. 3.

Electromagnetic phenomena are basic physical phenomena, and thus are within certain limits basic to all natural phenomena. The concepts of feedback in cybernetics are common to many levels of natural phenomena and engineering structures or systems. Also the concept of information or negative entropy is common to both physical phenomena and social phenomena.

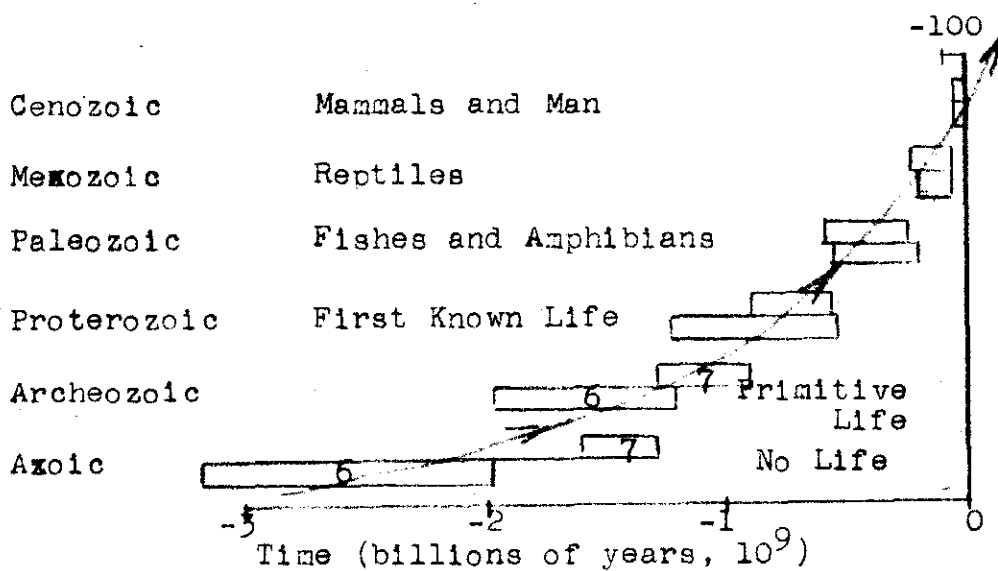
The historical perspective covers the period of the assumed existence of electromagnetic phenomena. Fig. 2 illustrates the approximate occurrence of events of the universe important to mankind, the geological era of the earth, and the development of mammals. Fig. 3 illustrates the development of man and the evolution of man's thinking.

³Lichtenberger, "Development of Social Theory,"
The Century Co., p. 368, 1923.



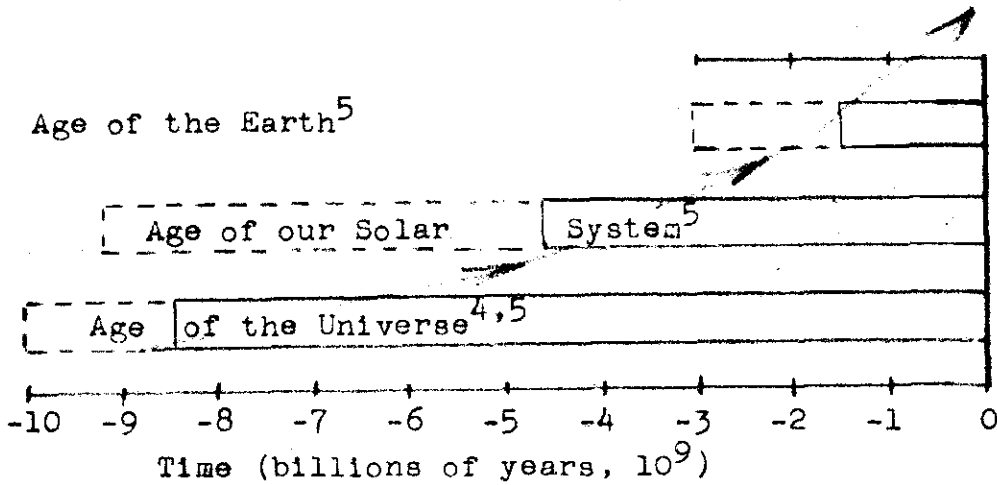
Geological Periods of the Cenozoic Era.

6th Order



Geological Eras of the Earth

7th Order



Stages of our Universe

8th Order

Partial Derivatives of History

Fig. 2. Historical Perspective (Part One)

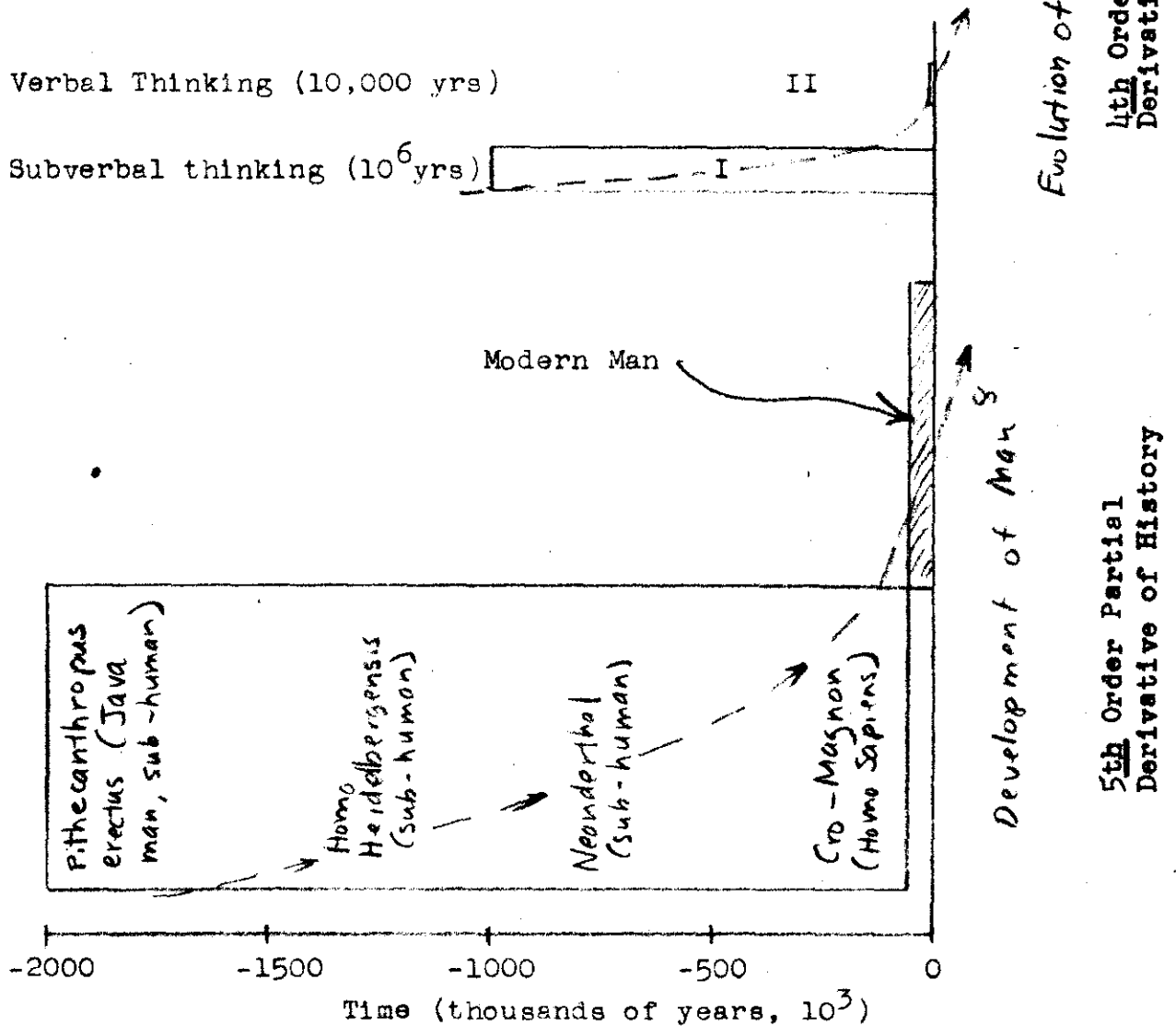
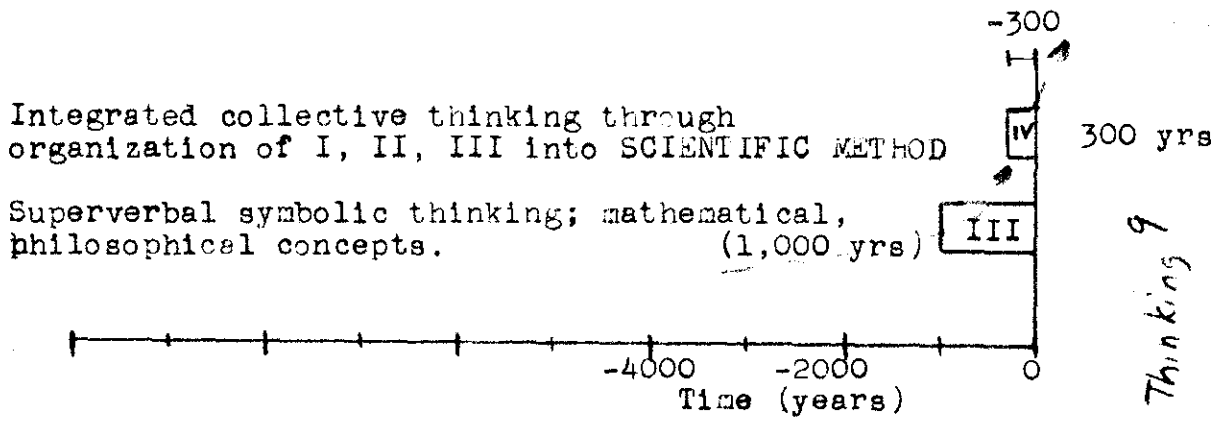


Fig. 3 Historical Perspective (Part Two)

References:

4. Edwin Hubble, "The problem of the expanding universe," *Science in Progress*, Third series, Yale University Press, pp. 22-44, 1942.
5. Pascual Jordan, "Die physik des 20. jahrhunderts," 1936, trans. by Eleanor Oshry, "Physics of the 20th Century," p. 29, 1944.
6. Ibid., p. 176 (from a compilation by O. Hahn)
7. John Phelan, "Anthropological backgrounds," in Elmer Pendell (ed.), *Society under analysis, An introduction to sociology*, p. 9, 1942.
8. Ibid., pp. 16-17.
9. Selden Smyser, "Logics: Subverbal, and superverbals," in *Papers from the First American Congress for general semantics*, March, 1935, Arrow editions, N.Y., 1940.
10. Note that estimates on the age of the universe have been changing. The estimate from references 4 (1942) and 5 (1936) ranged from 8.5 billion to 10 billion years. In Socio-Engineering Problems No. 2, Sept. 1958, p. 2, 10 billion years was used. At that time however astronomers considered that 6 billion years was a better estimate. In the Oct. 31, 1959 issue of Science News Letter, p. 289, a brief report of Dr. Fred Hoyle's latest calculation on an I.B.M. 704 computer indicates that 10 billion years is a better estimate. (For the technical details see Monthly Notices of the Royal Astronomical Society, Vol. 119, No. 2.)

Supplementary Notes

Fig. 1. This chart on distribution of emphasis partially suggests a direction to develop the equivalent to the Heine-Borel covering theorem suggested in SEP No. 7, page 5, Problem 7.1.2.(b).

From an earlier draft of the paper "History of Electromagnetic Theory":

Since this study of the history of electromagnetic theory is from an engineering viewpoint, it is necessary to clarify what is meant by engineering. A dictionary definition of engineering is as follows:

The art of making, building, or using engines and machines, or of designing and constructing public works or the like. 1

This definition must be modified by the following statement from the Encyclopaedia Britannica to arrive at the engineering viewpoint of this study:

...the engineer is under obligation to consider the sociological, economic and spiritual effects of engineering operations and to aid his fellowmen to adjust wisely their modes of living, their industrial, commercial and governmental procedures, and their educational processes so as to enjoy the greatest possible benefit from the progress achieved through our accumulating knowledge of the universe and ourselves as applied by engineering. 2

1. The Practical Standard Dictionary (Funk and Wagnalls Co., 1931).

2. Alfred Douglass Flinn, "Engineer, Professional," Encyclopaedia Britannica (1945), VIII, 443 b.

If Mr. Flinn's statement regarding the obligations of the engineer is to be taken seriously, a study of the history of electromagnetic theory from an engineering viewpoint should include consideration of the relationship of electromagnetic theory to social problems. A comprehensive study dealing with both physical and social phenomena requires a synthesis that would be very difficult to achieve in an age of extreme specialization. For a discussion of the dilemmas of specialization see SEP No. 13-A.